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A REVIEW OF THE LITERATURE: *COMPETITION VERSUS SOLE-SOURCE PROCUREMENTS*

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Competitive procurements often do achieve some savings over sole-source procurements, but a review of the literature analyzing this issue shows that the choice is not always straightforward. The savings is not always substantial, or is diminished by other costs associated with competition.

On what criteria should the decision to pursue competitive or sole-source procurement be based? A review of the literature brings several points to the fore. First, there is some rationale for supporting competitive over sole-source procurements, but not all competitive procurements produce savings; and the savings associated with going competitive are far less than the 25 percent cited by former Secretary of Defense Robert S. McNamara. Next, several factors should be considered prior to a decision to go competitive, such as production quantity, complexity of the item, capacity utilization of the industry involved, special skills, and sufficient data on the item. In addition, a cost-benefit analysis should probably be performed to determine the possible savings as a result of competition. Further, low dollar value spare parts, required in considerable quantity, or component parts and systems that are jointly used extensively by private industry, would

seem to be the best places to implement competitive procurements.

OLDER STUDIES ON THE BENEFITS OF COMPETITION

The previous research work in this area has seemed to follow a sequence, from more-or-less brief, rapidly compiled studies to more detailed and objective research over time. I thus reviewed the literature with the thought not only to compare the contract vehicles, but to consider the evolution of the studies, placing more weight on the on the later study efforts. To begin with, the early studies were generally based upon limited sample sizes, and dealt primarily with small systems or electronic components. These studies generally found consistent cost savings associated with competition programs, but in most

instances failed to take into account all the costs associated with the competition process, such as the cost of conducting competition, setup costs for the new contractor, special tooling and government-furnished equipment, and the time value of money to set up the new contractor. A brief discussion of these studies follows.

Carter (1974) proposed that the Air Force try "directed licensing," where the original contractor, during the development phase, agrees to provide rights in the data, and to an agreement to license whomever the government designates to produce the weapon system during any or all production runs following initial production. Carter felt this procedure would save money by forcing competition. He stated that previous contracting studies showed a 25 percent reduction in cost due to competition.

Olson, Cunningham, and Wilkins (1974) discovered that the cost savings associated with competition of spare parts ranged from 10 to 17 percent, with the most likely savings being 12 percent. They were cognizant of competition costs, but felt that for spare parts competitions, they generally would be negligible.

In a larger study, Zusman and Asher (1974) found that competition reduced costs by an average of 37 percent. However, as mentioned previously, they did not take into account the costs of conducting the competitions or their associated costs.

Lovett and Norton (1978) compared the price behavior on 11 competitive contracts that previously had been sole source. They found cost savings from 0 to 34 percent, but they also did not take into account the costs associated with competition.

Daly, Gats, and Schuttinga (1979) examined 31 programs and showed an average price reduction of 35 percent for competition on five missiles, a bomb, a guidance unit, and assorted electronic components. They speculated that savings for a "split award" would be about a 10 percent reduction, and a 20 percent reduction for winner-take-all competitions. This study failed to consider competition costs.

Drinnon and Hiller (1979) expanded upon the work of Lovett and Norton by reviewing 45 additional programs. They also found savings reductions ranging from -16 percent to 67.7 percent, with the median around 39 percent. Like the previous studies, most of the items were sub-assemblies and small electronic components. Major systems in their study only achieved 10-18 percent reductions (i.e., forward area alerting radar [FAAR], tube launched optically tracked wire guided missile [TOW] and Shillelagh) DEFINE. They likewise did not take into account the costs associated with competition.

Kratz and Cox (1982) expanded upon the conceptual framework of Drinnon and Hiller, and suggested that what transpired with the creation of competition was a shift and rotation of the

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learning curve, with an immediate drop in the first unit cost and a steeper learning curve. In applying their approach to five missile procurements, they found that the first unit cost was reduced by between 14 percent (4 percent shift and 8 percent rotation) to 46 percent (14 percent shift and 13 percent rotation). The model outlined in this approach is available from the Defense Systems Management College under the name of the Competition Evaluation Model (CEM), version 2.0 (1992). Beltramo (1989), however, took exception with the logic behind this model, and in a study performed for the Naval Center for Cost Analysis found only one example out of six cases where there was a shift and rotation. In the remaining cases, he found a downward initial shift with an upward rotation (i.e., a lower price for the first competitive lot, followed by a flatter learning curve than expected for the sole source).

It is hard to determine from these early studies how beneficial competition is to the procurement process, since they do not take into account the costs associated with conducting the competition, and the studies vary considerably in terms of consistency of

results from one study to the next, for the same data. However, it does seem obvious that there is a general cost savings associated with competition, especially on spare parts.

In an attempt to compare the studies' results for this problem of consistency, I reviewed the same procurements in different studies (see Table 1). In these systems (i.e., data points), there was considerable variability in results from one study to the next—where there should have been substantial similarity. For instance, some studies described a procurement as having produced a cost savings; other studies pronounced the same procurement to have caused a loss. Most striking were results for the Sidewinder 9D/G and the Sparrow 7F competitions, which were significantly different in different studies; other systems showed considerable variation from one study to the next. This variability can be attributed to the studies' use of different definitions, and, as a result, different costs were applied from one study to the next. Hampton (1984) presents a good example of how this occurs. On one system, the Shillelagh, he shows that savings can vary

Table 1. Variance Among Studies on Cost Savings

STUDIES	ZUSMAN	LOVETT	DALY	DRINNON	KRATZ	GREER	
SYSTEMS							Range
TOW	48	9	9	12	20	26	40
SHILLELAGH	0	6	-8	9	—	-5	17
BULLPUP	14	—	32	27	46	18	32
SIDEWINDER 9D/G	—	—	-5	1	—	-71	72
SIDEWINDER 9B	—	—	1	-6	17	—	23
SPARROW 7F	—	—	—	—	14	-25	39

from -14 percent to 22 percent depending upon the data used, statistical methods, and definition of what constitutes savings. The foregoing studies show that it is hard to place a firm number on the actual savings associated with competition.

SECOND PHASE OF STUDIES ON THE BENEFITS OF COMPETITION

Either as a result of the previous studies, or perhaps relating to increasing public interest in reducing defense costs, the DoD Cost Analysis Symposium of 1982 generated four papers on the topic of competition. These papers attempted to provide a more comprehensive approach to the question of savings resulting from competition; and also took a slightly different approach to research in this area, discussing several constraints that should be considered prior to a competition decision.

Trainor's review (1982) of Lovett and Norton and of Daly, Gates, and Schuttinga found that the majority of items (48/55) compared in these studies were nonmajor systems with unit costs of between \$4,100 and \$8,400 (fiscal year 1980 dollars). The only major weapons systems in these studies were one ship, one medium-size missile, and one small helicopter. He suggests that the results concerning the benefits of competition should only be applied to nonmajor system procurements. In addition, Trainor gives several reasons why competition may not either be practical or produce cost savings in the future, especially if current trends for defense contractors continue. These points are rather interesting, and in light of our current defense drawdown, will be discussed later.

Watkins (1982) followed up on the from Kratz and Cox model for estimating the slope for competitive contracts. He discussed the historical data by commodity area (e.g., electronics, missiles) and what the rotation and shifts could be for them based upon previous contracts. He also proposed the use of "should costs," using the model to determine the learning curve that the contractor should agree to for production.

Smith and Lowe (1982), like Watkins (1982), looked at the Kratz and Cox (1982) model for estimating the slope differences between competitive and sole-source procurements. Their results supported the shift and rotation premise and suggested that between a 15 and 25 percent savings on spare parts could be achieved by competition. They did not mention whether the cost of the competition was taken into account.

Carrick (1982) discussed experience curves and the factors that influence them. Like Trainor (1982), he mentioned that contractors have several problems in their estimation process for competitive bids that may cause cost growth over the initial estimate. For instance, in the DIVAD program the winning contractor had not even generated designs for several of the equipments, yet submitted a cost estimate for them. Also, in the Viper and Copperhead programs, neither of the winning contractors adequately understood the technology underlying their designs, much less the exceptional difficulties in defining and implementing a high rate of production technology. These examples point out that one cannot just use the bid price from the contract as data for competition studies; the actual production costs should be used.

MORE COMPREHENSIVE STUDIES ON COMPETITION

Following this period, the research on sole-source versus competition changed from somewhat simple comparisons to multiple factor analyses. These studies recognized that there were several possible factors that could come into play in affecting the costs associated with contracting. A number of these well-done studies were master's theses from the Air Force Institute of Technology.

Brost (1982) conducted a regression approach to determine the savings associated with competition, comparing the estimated sole-source cost on spare parts procurements to the actual competition prices, controlling for inflation and commodity type. His results ran counter to the earlier spare parts studies, and indicated a general negative trend as a result of competition. These results could have been influenced by the small number of procurements that met his criteria for inclusion into the study (36). Further, while recognizing that there were additional costs associated with competition, the study did not add these costs to the competition side of the equation; had they been, the results of this analysis would be even less favorable toward competition.

Zamparelli (1983) followed up on this spares analysis, and, in turn, found some savings associated with competition (4.1 to 11.2 percent). But in several instances competition was not found to be beneficial. For example, where relatively few companies can supply a particular aircraft engine's spare parts, even if proprietary data are not involved, competition was not effective in reducing

costs, since the second source of supply may need to retool and change its machine specifications in order to produce the parts. In addition, when the spare parts exceeded \$1,000 in unit costs, competition did not save money. Finally, there were some instances in which competition increased costs by two to eight times the sole-source cost— but these instances may stem from the part not being manufactured any longer. The study, like the previous studies, did not consider the cost of competition in its analysis.

Greer and Liao (1983) investigated contractor profitability and capacity utilization in relation to competition cost savings. Using three of the six missile competitions from Kratz and Cox (1982), they concluded that competition produces greater savings when firms are at low capacity. But when capacity utilization was high, there was little benefit attributed to competition. The worst cases occurred when capacity utilization was above 80 percent. In those instances, there were net losses associated with competition.

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Heinz (1983) looked at a factorial approach to sole source versus competition. He suggested that for the early development of armament systems sole sourcing was best, but, as the systems matured to the 6.5 level, competition became more favorable. His suggestions seemed to principally be related to the complexity of the system, in that the more complex the process, the more appropriate sole source became.

Hampton (1984) produced an excellent paper that reviews the above-mentioned studies, critiquing them upon their methodology and suggesting a more appropriate approach to determine if competition was worthwhile. Generally, he came to the conclusion that competition was not always cost effective or practical, and that in order to determine if there were any advantages to a system going competitive, a cost-benefit analysis should be performed that would take into account all the costs associated with the

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government and the contractors, and would use discounted dollars in accordance with OMB Circular A-94. His paper was basically broken into three sections. The first section was a complete discussion of previous research, then the factors that should be considered in determining if com-

petition were cost effective, and, third, a discussion of a cost-benefit approach that could be applied to determine the reasonableness of competition. He also discussed, in the second section, several studies that took these additional government and contractor costs into account, and found that competition was not cost effective for those systems.

Gable (1985) looked at whether competition reduced spare parts procurement costs. The study did indicate a savings associated with competition, but he states that competition is not always possible for several reasons (e.g., inadequate or missing data, proprietary rights, shrinking industrial base).

He recognized also that there are several costs associated with competition that might outweigh the benefits in gross savings (competition personnel costs, contracting personnel costs, increased processing time required to conduct the competition, and the additional paperwork required).

Presar (1986) discussed how the pressure to increase competition would cause increasing workload requirements on the commodity commands, in terms of personnel and time to conduct these procurements. These manpower requirements would be borne by the commodity commands and would not be funded by the weapons systems nor out of the normal command's budget, thus causing the offices in those commands to absorb the increased man-hours out of their existing workforce.

Berg, Dennis, and Jondrow (1986) performed a literature review of the previous studies on sole-source versus competitive procurement. They recognized the inconsistencies of the previous studies and attempted to outline why differences may have occurred (e.g., use of differing data, different adjustments, different assumptions). Their recognition of these possible problem areas and the subsequent effect upon the previous studies was quite good. They also suggested that the price improvement curve model of Kratz and Cox (1982) may not take enough variables into consideration for true forecasting purposes.

In his book *Affording Defense*, Gansler (1989) discusses how the “fair and open environment” that Congress has created can lead to too many bidders entering the competition—more than is good for either the government or for the contractors themselves.

He describes one case in which DoD spent time and money evaluating fifty bids for a few-hundred-dollar item. Situations like these hardly make sense, and can promote inexperienced, weak manufacturers, when DoD with its substantial buying power should be obtaining the most effective weapons for the lowest cost. He also stresses the importance of continuous competition, where, if possible, not only the initial procurement is competed but also the production contracts; preferably with a leader-follower award, so that there continues to be competitive pressure on manufacturers. He emphasizes, however, that competition should make sense, and that, in an environment stressing competition and low cost, the quality of DoD items could be threatened if it is carried too far. He sums up these concepts with the following statement: "Competition for its own sake is clearly wrong; however, when competition makes good management sense and when best value is emphasized, that is a different story."

Kitfield (1989) discusses whether some programs represented as competitive were really so. He also describes a Navy study of eight separate weapons systems that estimated the cost of bringing on a second source at 2-4 percent of the total cost of the procurement.

Boger, Greer, and Liao (1990) assert that competition in weapons systems procurement does not always produce savings. They reemphasize Greer and Liao's (1983) previous study, where capacity utilization above 80 percent produced losses when systems were competed. They also discussed several factors that could make competition less effective than in private industry: when the government is the sole buyer, with only

limited production and few companies capable of producing the items, the government is required to help establish the second source.

Flynn and Herrin (1990) show that the Navy has been having success with competitive procurements on large weapons systems, achieving a 14 percent savings (these savings did not take all competition costs into account, however). They estimate that the startup costs for the second source represented 2.4 percent of the total program costs. But they temper the 14 percent estimate by saying that the previous procurements occurred during the 1980s defense buildup, and may not hold in the current defense drawdown period with reduced quantities.

Carlson, Hamre, and McNicol (1990) discussed several issues concerning weapons system competitions at the DoD Cost Analysis Symposium (1989). This was the second time that a majority of symposium papers dealt with competition (1982). The authors covered several areas of possible concern for future competition, such as

system complexity and whether complexity itself would preclude dual sourcing. They also asserted that dual sourcing may be driving companies to share less information with one another, out of fear that they may end up competing at a later

date, and that this impaired the technical capability associated with new defense technologies. They also stated that the current

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preoccupation with price is not in keeping with the new trends in total quality management, and that best value should be the principal goal for defense procurements.

Elliot (1990) reviewed the impact of competition on the quality of the items procured. The study found no significant difference in quality as a result of changing from a sole-source to a competitive producer. However, these procurements were for spare parts and may not be representative of major systems or components under development.

Wandland and Wickman (1993) found, as have authors of previous studies, that competition resulted in reduced costs over sole-source procurements, though the difference was not statistically significant. The study also examined the question of whether contractors might be buying in on competitive contracts. Here they found that counter to expectations, competitive contracts had less cost and schedule growth than sole-source

contracts, though the differences were not statistically significant. Like previous studies, the costs associated with competition were not considered in their results, though they were aware of several

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competition costs (i.e., technology transfer to second source, additional government management, time value of money, purchasing procurement data, special tooling and test equipment).

DISCUSSION

Given the variability of results from the preceding studies, and the subsequent recognition that several factors are involved in the ultimate determination of whether competition is cost effective, it seems prudent to take a conservative approach to the question of when competition should be used. Like several other investigators in this area, I have come to the conclusion that competition “savings” are dependent upon several factors, ranging from industrial base issues to how costs are defined in the analysis. Trainor (1982) and Gable (1985) discussed several industrial base issues that could influence production costs, and that should be considered when deciding whether to use sole sources or competition to procure an item.

One of these issues is **production rate**. In single-line production (where only one type of item can be produced on the production line), higher production rates allow more efficient production, and so, lower costs. This factor was coming into play in 1982, with decreasing production rates, and has continued to be a factor as weapon systems have become more complex, and require higher sophistication than standard manufacturing products.

The **stable production rate** is another important factor. In single-line production, a stable production rate allows for more efficient production, and so, lower costs. Stable production rates were becoming a problem for military manufacturers in 1982, and have continued to be a factor as funding for military programs has undergone continuing readjustments, which in turn causes production slippages.

Production quantity is a combination of the previous two factors. In single-line

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production, large quantities allow more efficient production, and so, lower costs. This factor had been decreasing for 10 years prior to 1982, and continues to decrease in the present environment.

Time required to stabilize design is another element to consider. Unless the design is firm, there is the possibility of cost growth. The increased complexity and testing requirements of weapon systems back in 1982 prompted this concern, which has continued to increase with the current sophistication and complexity of state-of-the-art systems. Some examples from Carrick's study (1982) were the DIVAD program, in which the winning contractor had not even designed several of the components when it submitted the bid. In the Viper and Copperhead programs, neither of the winning contractors adequately understood the technology or the high rate production techniques required when they bid on these systems.

Capacity utilization (in terms of both workers and facilities) is another issue that affects savings. As a company's plant utilization increases, the associated costs for its product decrease because of a reduction in overhead and excess capacity. This point was also recognized by Greer and Liao (1983) and Boger, Greer, and Liao (1990): When capacity utilization exceeds 80 percent, the superiority of competition over sole-source acquisition begins to diminish, perhaps because companies' efficiencies then operate at about the same level, and their costs are similar. Defense contractors continue to merge, and most are now operating at or near full capacity; they cannot achieve significant savings by reducing excess overhead.

Special production skills and facilities also affect the sole source versus competition decision. It is easier to establish a second

production source if the need for specialized skills and facilities does not exist. However, with weapon systems becoming increasingly unique, only limited facilities are available to produce some systems (e.g., tanks, submarines, aircraft carriers), so that the pool of competitors for an increasing number of weapon systems is reduced. Zamparelli (1983) found that relatively few companies could supply the components to manufacture aircraft engine parts.

It is difficult to establish a second production source if **production drawings** are not available. As funding has become tighter over the years, several programs have opted for reducing the number of system drawings for their components, or not updating those drawings as design modifications have changed the components.

Proprietary data rights also affect sole-source versus competition decision. It is difficult to establish a second source if the system or component uses proprietary information. Many contractors incorporate components and parts in theft systems for which they hold the proprietary rights.

In addition, several costs associated with competition must be taken into account to determine if competition will really save money. Hampton (1984) and Beltramo (1990) discuss several of these in detail:

- the source selection costs, which includes both the government personnel and facilities required, along with the contractor's cost to develop the proposal;
- second source development costs, such as updating the technical data

package, special tooling and test equipment required, cost of transferring the technical data to the new source, and first article testing;

- other possible liabilities to the government, concerning the undepreciated assets that the government may have to pay for, or furnish to the new source;
- quantity and learning curve losses in production, if quantities are split between several sources;
- increased technical data administration costs, for updating more than one source; and
- company-funded research and development costs that need to be recaptured by the original developer.

Added to these are the logistics costs associated with maintaining multiple versions of a system in the inventory, and the required spare parts unique to each version. These costs have not been discussed in the literature. Tied into this is the increased training required for repair of the different versions, and their respective technical manuals.

To thoroughly cover the topic, I discussed these issues with the leading professors and experts in the field: Beltramo (1996), Fullerton (1995), McAfee (1995), Rao (1995), Rogerson (1995), Vincent (1995), Wilson (1995), and Yao (1995). From these discussions I learned of additional studies and books the initial literature searches did not uncover.

Anton and Yao (1987, 1989, 1990, and 1992) have published several theoretical papers on the effects of full costing knowledge versus incomplete information on the bidding process. They point out that the developer's production experience provides a cost advantage over a second-source bidder, but this pricing advantage can be offset if it is not opened to competition later, and the initial cost information is provided to all bidders. They also note that in an environment with unequal cost information, both the bidder and the buyer benefit from a split award over a winner-take-all award; in an open cost knowledge environment, the buyer receives a lower cost under a winner-take-all process.

Recently, Fullerton (1995a and 1995b), Fullerton and McAfee (1996), and Taylor (1995) have expressed some novel and interesting proposals concerning competition. These are termed "research tournaments," in which the competition procedure is structured as an auction and prototype competition, with the winner awarded a "prize" for the best product. The auction component consists of the participants paying a fee for entering the tournament, which could be pooled across the participants to defray the cost of the prize, or offset the cost of conducting the competition. This prize could either be a set amount of money based upon what the government determined the work effort to be worth, or, if the contract award was large enough or had commercial applications, the award would merely be the winning of the contract, since the follow-on work would generate sufficient commercial incentive.

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An article on optimal procurement mechanisms by Manelli and Vincent(1995) is similar to the work of Anton and Yao above (1987, 1989, 1990, and 1992) and looked at theoretical competitions. He proposed that the optimal competition environment would be first to offer to a select group of companies, in a sequential process, a fixed price to perform the work, and if they all should reject the price, then hold an auction.

CONCLUSIONS

This review of the competition-versus-sole-source procurements literature makes apparent the following points. First, there is probably some rationale supporting competitive over sole-source procurements, but not all competitive procurements produce savings; and the savings are probably far less than 25 percent. Next, one should consider several factors before a competitive procurement is chosen; these include production quantity, complexity of the item, capacity utilization of the industry involved, special skills, and sufficient data on the item. In addition, decision makers should probably perform a cost-benefit analysis before choosing competitive procurement, to determine if that avenue will actually result in any savings. Lastly, competition is probably the best choice for acquisition of low-dollar-value spare parts required in considerable quantity, or for component parts and systems that are jointly and extensively used by private industry.

Currently, competition is the prescribed means of procurement, but we should be aware of its ramifications both for private industry and the military. The current hypersensitivity of private industry concerning

research and manufacturing technologies (apparent from companies' great concern about sharing information with other contractors, for fear that they may be competing in the future) is one result of this policy. Carlson (Carlson, Hamre, and McNicol, 1990) discussed this effect with Hamre and McNicol at the 1989 Department of Defense Cost Analysis Symposium, and pointed out that in the past, when specific companies had "baronies" for a particular area, they maintained top-notch engineers for long periods of time at one location. These groups of experts generated a research synergy that led to the development of new technologies and a willingness to share technical information with other industries. Carlson's statement that this situation no longer exists has recently been echoed by industry representatives who describe today's environment as "kill or be killed" (*National Defense*, 1996). Companies hide what they are doing, and do not allow their employees to discuss their work at symposiums of like the American Defense Preparedness Association, or the National Industrial Security Association meetings. This, in turn, he stressed, handicaps development of new technologies in these defense industries, and drives the armed services to depend more on commercial developments to generate the high-technology equipment required to maintain an edge over other countries. Hamre pointed out the current overemphasis on cost cutting, which runs contrary to principles of total quality management, where price is not the primary issue. This point of view has caused a change in recent years to "best value" competitions, where quality and value are considered in relation to price.

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